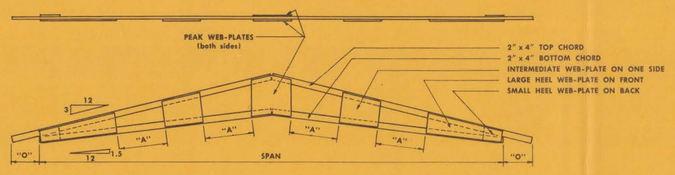
SLOPED CEILING, PLYWOOD WEB ROOF-FRAME

2′-0″ ON CENTER, 21′-0″ TO 32′-8″ SPANS
3/12 ROOF SLOPE; 1.5/12 CEILING SLOPE

21′-0″ TO 24′-8″ SPANS — 2″ x 4″ Chords



DESIGN DATA

Spans of 21′-0″ to 24′-8″
Slope of 3/12 -1.5/12

Recommended Design Load *(pounds per square foot of horizontal projection)*
Roof *(dead load + live load)* 40 psf
Ceiling *(dead load)* 35 psf
5 psf

PERFORMANCE DATA ON 24′-8″ TEST

Maximum allowable deflection *(1/360 span)* 0.82″

Deflections at design load
quarter points 0.12″
mid-span 0.25″

Test load at failure 125 psf

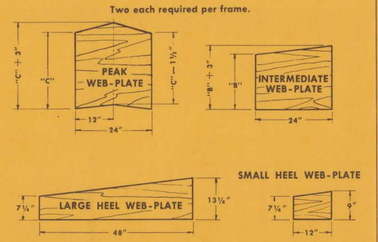
CUTTING SCHEDULE

SPAN		21′			22′			23′			24′		
		0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″
TOP CHORD	2″ x 4″	14′-0″						16′-0″					
OVERHANG	"O"	37″	35″	33″	31″	29″	27″	25″	46¼″	44¼″	42¼″	40¼″	38¼″
BOTTOM CHORD*	2″ x 4″	10′-7″	10′-9″	10′-11″	11′-1″	11′-3″	11′-5″	11′-7″	11′-9″	11′-11″	12′-1″	12′-3″	12′-5″
WEB-PLATE SPACING	"A"	21⅛″	22⅛″	23⅛″	24⅛″	25⅛″	26⅛″	27⅛″	28⅛″	29⅛″	30⅛″	31⅛″	32⅛″
INTERMEDIATE WEB	"B"	15¾″	15⅞″	16″	16⅛″	16¼″	16⅜″	16½″	16⅝″	16¾″	16⅞″	17″	17⅛″
PEAK WEB	"C"	21⅜″	21⅞″	22⅛″	22⅜″	22⅝″	22⅞″	23⅛″	23⅜″	23⅝″	23⅞″	24⅛″	24⅜″
HEIGHT (see jig layout)	"H"	31 15/16″	32 7/16″	32 15/16″	33 7/16″	33 15/16″	34 7/16″	34 15/16″	35 7/16″	35 15/16″	36 7/16″	36 15/16″	37 7/16″
	"h"	15¾″	16″	16¼″	16½″	16¾″	17″	17¼″	17½″	17¾″	18″	18¼″	18½″

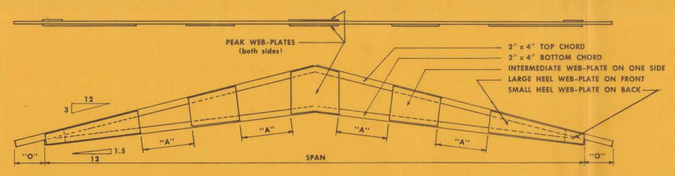
* Bottom chord dimension is for square-end cut. Make bevel cuts on this member as shown in Heel Joint Detail.

WEB-PLATE PATTERN — ½″ Plywood

Dimensions "B" and "C" are given in the Cutting Schedule. Make sure the grain of the plywood runs parallel to the bottom chord.



25′-0″ TO 28′-8″ SPANS — 2″ x 4″ Chords



DESIGN DATA

Spans of 25′-0″ to 28′-8″
Slope of 3/12 -1.5/12

Recommended Design Load *(pounds per square foot of horizontal projection)*
Roof *(dead load + live load)* 40 psf
Ceiling *(dead load)* 35 psf
5 psf

PERFORMANCE DATA ON 28′-8″ TEST

Maximum allowable deflection *(1/360 span)* 0.96″

Deflections at design load
quarter points 0.52″
mid-span 0.52″

Test load at failure 176 psf

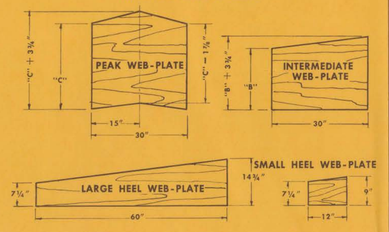
CUTTING SCHEDULE

SPAN		25′			26′			27′			28′		
		0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″
TOP CHORD	2″ x 4″	16′-0″						18′-0″					
OVERHANG	"O"	36¼″	34¼″	32¼″	30¼″	28¼″	26¼″	24¼″	46½″	44½″	42½″	40½″	38½″
BOTTOM CHORD*	2″ x 4″	12′-7⅛″	12′-9⅛″	12′-11⅛″	13′-1¼″	13′-3¼″	13′-5¼″	13′-7¼″	13′-9¼″	13′-11¼″	14′-1¼″	14′-3¼″	14′-5¼″
WEB-PLATE SPACING	"A"	22⅝″	23⅝″	24⅝″	25⅝″	26⅝″	27⅝″	28⅝″	29⅝″	30⅝″	31⅝″	32⅝″	33⅝″
INTERMEDIATE WEB	"B"	17⅜″	17½″	17⅝″	17¾″	17⅞″	18″	18⅛″	18¼″	18⅜″	18½″	18⅝″	18¾″
PEAK WEB	"C"	24¼″	24½″	24¾″	25″	25¼″	25½″	25¾″	26″	26¼″	26½″	26¾″	27″
HEIGHT (see jig layout)	"H"	37 15/16″	38 7/16″	38 15/16″	39 7/16″	39 15/16″	40 7/16″	40 15/16″	41 7/16″	41 15/16″	42 7/16″	42 15/16″	43 7/16″
	"h"	18¾″	19″	19¼″	19½″	19¾″	20″	20¼″	20½″	20¾″	21″	21¼″	21½″

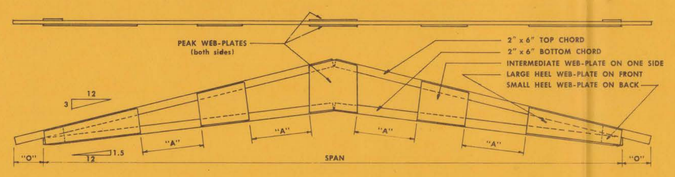
* Bottom chord dimension is for square-end cut. Make bevel cuts on this member as shown in Heel Joint Detail.

WEB-PLATE PATTERN — ½″ Plywood

Dimensions "B" and "C" are given in the Cutting Schedule. Make sure the grain of the plywood runs parallel to the bottom chord.



29′-0″ TO 32′-8″ SPANS — 2″ x 6″ Chords



DESIGN DATA

Spans of 29′-0″ to 32′-8″
Slope of 3/12 -1.5/12

Recommended Design Load *(pounds per square foot of horizontal projection)*
Roof *(dead load + live load)* 40 psf
Ceiling *(dead load)* 35 psf
5 psf

PERFORMANCE DATA ON 32′-8″ TEST

Maximum allowable deflection *(1/360 span)* 1.09″

Deflections at design load
quarter points 0.56″
mid-span 0.64″

Test load at failure 120 psf

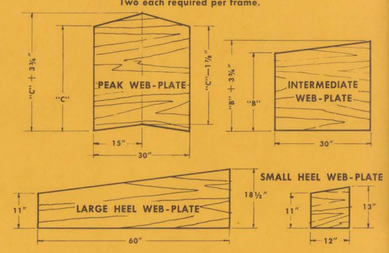
CUTTING SCHEDULE

SPAN		29′			30′			31′			32′		
		0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″
TOP CHORD	2″ x 6″	18′-0″						20′-0″					
OVERHANG	"O"	36½″	34½″	32½″	30½″	28½″	26½″	24½″	46″	44″	42″	40″	38″
BOTTOM CHORD*	2″ x 6″	14′-7⅜″	14′-9⅜″	14′-11⅜″	15′-1⅜″	15′-3⅜″	15′-5⅜″	15′-7⅜″	15′-9⅜″	15′-11⅜″	16′-1⅜″	16′-3⅜″	16′-5⅜″
WEB-PLATE SPACING	"A"	34¾″	35¾″	36¾″	37¾″	38¾″	39¾″	40¾″	41¾″	42¾″	43¾″	44¾″	45¾″
INTERMEDIATE WEB	"B"	22½″	22⅝″	22¾″	22⅞″	23″	23⅛″	23¼″	23⅜″	23½″	23⅝″	23¾″	23⅞″
PEAK WEB	"C"	31″	31¼″	31½″	31¾″	32″	32¼″	32⅜″	32⅞″	33⅛″	33⅜″	33⅝″	33⅞″
HEIGHT (see jig layout)	"H"	43 15/16″	44 7/16″	44 15/16″	45 7/16″	45 15/16″	46 7/16″	46 15/16″	47 7/16″	47 15/16″	48 7/16″	48 15/16″	49 7/16″
	"h"	21¾″	22″	22¼″	22½″	22¾″	23″	23¼″	23½″	23¾″	24″	24¼″	24½″

* Bottom chord dimension is for square-end cut. Make bevel cuts on this member as shown in Heel Joint Detail.

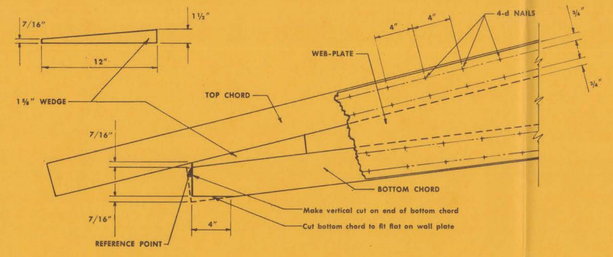
WEB-PLATE PATTERN — ½″ Plywood

Dimensions "B" and "C" are given in the Cutting Schedule. Make sure the grain of the plywood runs parallel to the bottom chord.

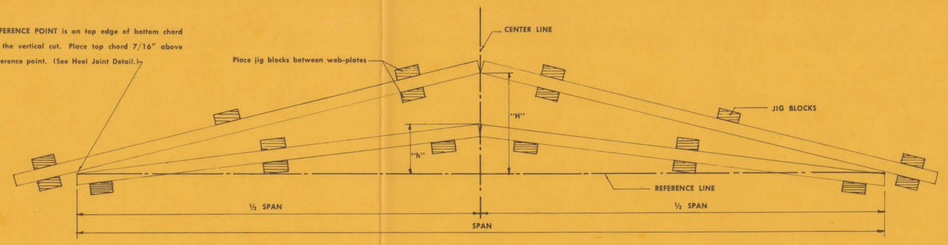


HEEL JOINT DETAIL — NAIL SPACING FOR 2″ x 4″ Chords

(ADD CENTER ROW FOR 2″ x 6″ CHORDS)



JIG LAYOUT



STRUCTURAL DESIGN DATA

- The graphical methods of analysis (funicular polygon) generally used for trusses designed with pin-connected joints should not be used for analyzing trusses with nail-glued plywood gussets because the results will be inaccurate. Funicular polygons show only tension or compression stresses in a structure, and in no way indicate the combined stresses due to secondary bending. Analytical methods of structural analysis are also unreliable. The plywood web-plates used in this roof-frame form rigid connections between the chord members. Stresses are transferred through the web-plates into a long length of the chord members. The stress distribution in the plywood web-frame is considerably different from that in a scissor truss with pin connections.

The heel web-plate resists stresses of shear from the reaction, compression from the top chord, and tension from the lower chord. These stresses are combined and distributed through the web-plate. The intermediate web-plate stresses are essentially compression, and the peak web stresses are tension, but all webs have shearing stresses at the edge of each chord connection.

The performance characteristics of the sloped ceiling, plywood web roof-frame under load are deflection in each lower chord, an over-all deflection, and a spread between the heels. Performance tests determined the proper web-plate sizes to eliminate excessive deflections and spread. The design of the sloped ceiling, plywood web roof-frame is based on test results 1) from full-size trusses tested individually in a hydraulic testing machine, and 2) on pairs of trusses set up 24″ on center, sheathed, bridged for lateral support, and loaded with concrete block for live load on the roof surface and bottom chord. Three types of tests were made to determine the performance of a design: load-and-recovery, long-duration load, and load-to-destruction tests.

In the load-and-recovery test (a performance test to observe the behavior of a truss under loads that exceed design loads), a load of 100 lbs. per sq. ft., equaling two and one-half times the predicted design load, was applied to the truss. Deflection readings were taken as the load was applied in increments of 20 lbs. per sq. ft. Residual deflection was measured after the entire load was removed. This test determined the maximum load the truss can carry for acceptable performance, based on the allowable deflection of 1/360 of the span. The deflection and spread of the web frames tested were only a fraction of the deflection and spread found in tests of conventional rafters and ceiling joists. The long-duration test was an accelerated time test lasting 120 days with a design load applied to the truss. The test exposes any deformation or creep that might occur due to the heavy loads imposed for a long period. Stiffness is a general characteristic of nail-glued trusses, and they show very little creep under long-duration tests.

The destruction tests determined the maximum load capacity of the roof-frame, behavior when greatly over-stressed, and the critical points of the design. The sloped ceiling, plywood web roof frame will carry from 2 to 4 times the predicted design load before failure. In every case observed, failure occurred in either the top or bottom chords. Failure never occurred in plywood webs or in the glue bond.

MATERIALS AND NAIL-GLUING FABRICATION

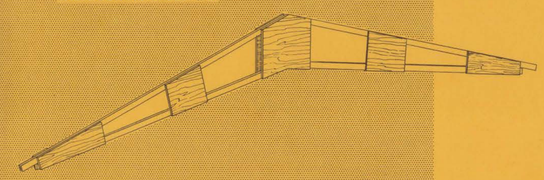
- Each structural member should have a moisture content of 19% or less.
- Structural lumber for the 2 x 4 chords must be at least No. 2 K. D. southern yellow pine (1500 psi., stress grade) or reselected construction grade Douglas fir or western hemlock. (See reselection procedure given in Small Homes Council Instruction Sheet #12, *Reselection of Lumber for Roof Trusses.*) The lumber reselected by this process is equivalent to 1500 psi., stress grade, throughout its entire length. 2 x 6 material must be at least No. 2 K. D. southern yellow pine, or "construction grade" Douglas fir or western hemlock.
- Use unsanded grade plywood, ½″ thick. The plywood must meet Commercial Standards CS45-55 as certified by an approved testing laboratory.
- The surface grain of the plywood should run parallel to the bottom chord for all plates.
- Use 4-d nails or 1¼″ staples spaced as shown in "Heel Joint Detail" for 2″ x 4″ members. Use three rows on 2″ x 6″ members. Fasteners should be ⅜-inch from edges of the plywood.
- The casein glue must meet Federal Specification MMM-A-125, Type I or II. (Type II contains a mold inhibitor.) Mix the glue according to the manufacturer's instructions. Protect the trusses from rain. After nailing, stack the trusses and do not handle them during the curing period.
- Fabricate and cure the trusses above 50° F. When the temperature is between 50° F. and 70° F., a 16-hour curing period is necessary; when the temperature is 70° F. or above, an 8-hour curing period is needed.

SLOPED CEILING, PLYWOOD WEB ROOF-FRAME

3/12 Roof Slope; 1.5/12 Ceiling Slope

2′ on Center, 21′-0″ to 32′-8″ Spans

INSTRUCTION SHEET #8



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Materials and nail-gluing fabrication instructions revised in 1959 by Rudard A. Jones, registered architect, and Donald H. Percival, wood technologist, University of Illinois Small Homes Council – Building Research Council

This publication results from a study conducted jointly by the University of Illinois and Purdue University

Price: 50 cents

Suggested A. I. A. File Number 19 B 3